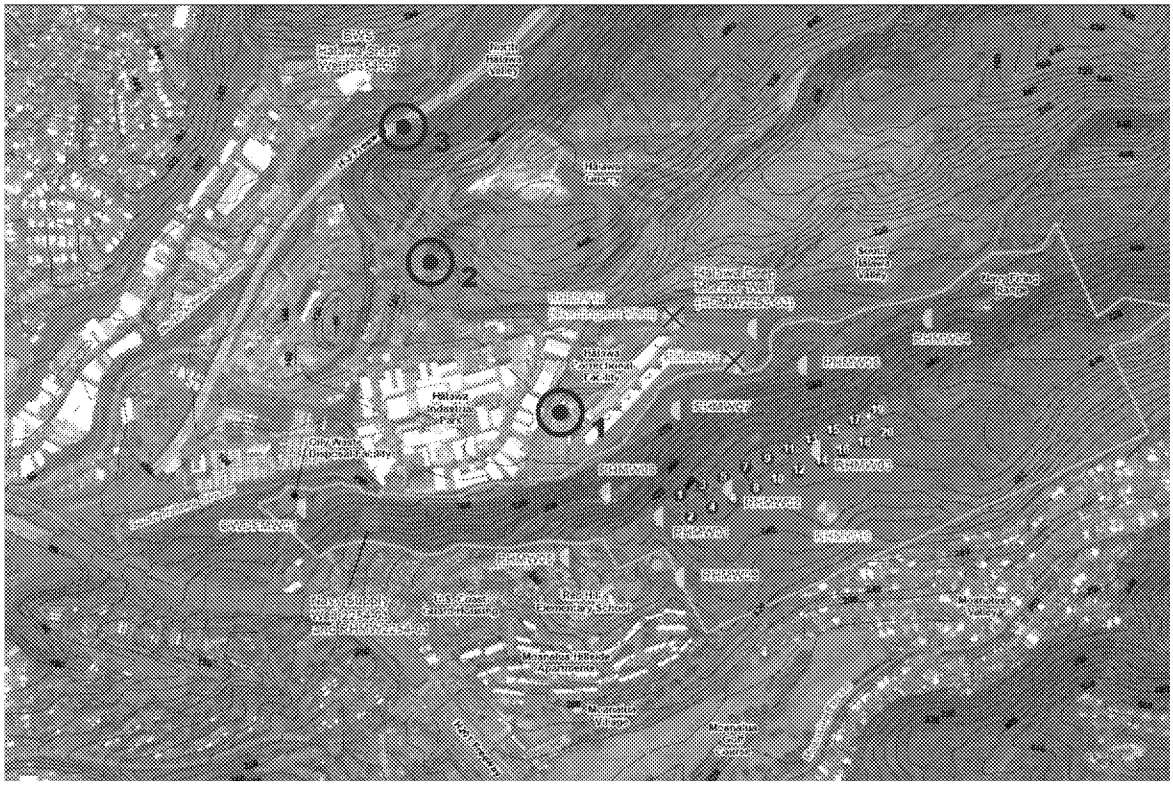
R. Chinn – 02/28/17



R. Chinn – 02/28/17

- **Well Location 1:** Propose targeting the center of the saprolite in the S. Halawa Valley makai of the Correctional Facility. Used in conjunction with the Halawa Deep Well, this well should be able to provide information about how the depth of saprolite varies with respect to distance toward Pearl Harbor. Groundwater elevations would be useful in constructing the groundwater model. My hypothesis is that GW at this location is lower than both at the Deep Well and at Red Hill – though the Deep Well may not provide representative elevations since it's screened so differently from all other wells. [Note that the well could be installed at the north end of the Correctional Facility parking lot.]
  - Need to ensure that the water level referred to is that in the basalt. The low permeability of the alluvium/saprolite will result in elevated water levels in these zones that may be continuous down to the permeable basalt. See Rotzoll's modeled GW elevations. Also, this well would not be optimally located to intercept contamination since it would flow around the valley if there is flow from the Moanalua Aquifer to the Pearl Harbor Aquifer.

- **Well Location 2:** Propose targeting the center of the Quarry spur between North and South Halawa valleys. My hypothesis is that the groundwater elevation here will be marginally higher than found at Location 1 and the Deep Well. If this turns out to be the case, the groundwater flow direction will become clear when modeled. [Note that while this is in the center of the Quarry's operations, there is a large clearing that could be used for drilling purposes.]

- **Well Location 3:** Propose targeting the center of the N. Halawa valley to evaluate the depth of saprolite. Past literature suggests that the N. Halawa Valley is older than S. Halawa Valley, so the depth of saprolite may be greater...though it's unclear why the valley is so narrow here. If the saprolite extends well into groundwater, it represents a barrier to contaminant migration. While I agree that relying on this barrier as a line of defense against contaminant migration to Halawa Shaft is far less than ideal (i.e. it's way too close for comfort), the extent of saprolite is necessary for the purposes of the model. I hypothesize that the groundwater elevation here is marginally lower than found at the Quarry spur, though highly influenced by Halawa Shaft. [Note that there is an access road along the south side of H3 with a turnout. This could be used as the drilling location.]

- **Removal of RHMW11 and RHMW12:** Based on a review of the proposed locations, it seems that the lithology in center of S. Halawa valley is adequately described by the Deep Well. RHMW11 is unlikely to show saprolite extending to the groundwater table, as it's probably too close to Red Hill. Likewise, RHMW12 is also unlikely to show saprolite extending to the groundwater table, as it's probably too close to the Quarry spur. Of course there is some marginal benefit to these wells, but I'd rather see the money spent elsewhere.
- **Global Point –** Wells will be single point information that are not necessarily be able to extend up or down valley to understand how the geology found in the borehole will affect LNAPL and dissolved, and groundwater flow. Need to characterize water level and the structures in this region over a fairly broad area to understand groundwater flow.

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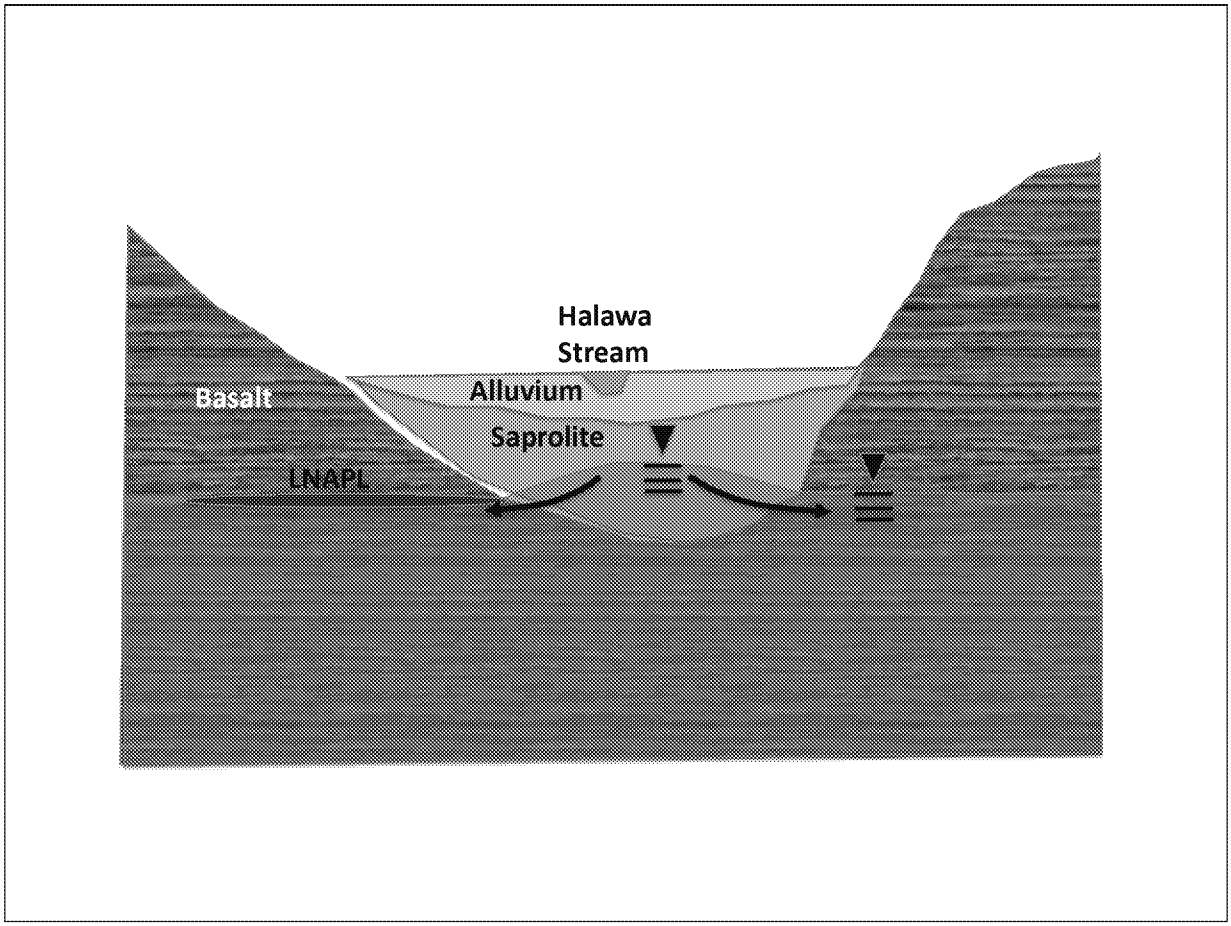
- **Ground Truth** – wells could be used as ground truth other techniques of evaluating the sub-surface.
- **Groundwater Flow –** using available data it is incorrect to assume that the groundwater flow direction is parallel to alignment of the tanks. Taken at face value, using available TOC elevations the gradient is either flat down to RHMW01 or very slightly toward RHMW04.

Red Hill Investigation

1. TOC Elevation Survey
2. Compile analyze stratigraphic data in context of new well placement
3. New well placement decision (after Synoptic/TOC/WL analysis)
4. Compile, validate, review, and interpret available chemistry data (inorganic, contaminant [including chromatograph interpretation], isotope)
5. Identify method to map the subsurface in 2 or 3d; alluvium, saprolite, basalt interfaces
    1. Cost <= 1 monitoring well
6. A well designed and executed tracer test can remove a lot of uncertainty.


Halawa
Stream
Basalt
Alluvium
Saprolite
LNAPL

Water Table Elevations Nov 2016 Synoptic WL Survey
Halawa Shaft WL estimated based on USGS May 2015 Aquifer test w/ no Halawa Shaft Pumpage